

Chapter 15

CO₂ Underground Storage and Wellbore Integrity

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ABSTRACT

Geologic storage is the component of Carbon Capture and Storage (CCS) in which the carbon dioxide (CO₂) is disposed in the appropriate underground formation. To successfully inject CO₂ into the subsurface to mitigate greenhouse gases in the atmosphere, the CO₂ must be trapped in the subsurface and must not be allowed to leak to the surface or to potable water sources above the injection zone. For the purposes of risk assessment, a priority is to evaluate what would happen if CO₂ migrated unexpectedly through the confining unit(s), potentially resulting in undesirable impacts on a variety of potential receptors. One of the main risks identified in geological CO₂ storage is the potential for CO₂ leakage through or along wells. To avoid leakage from the injection wells, the integrity of the wells must be maintained during the injection period and for as long as free CO₂ exists in the injection zone.

INTRODUCTION

Carbon capture and storage (CCS) is becoming a critically important part of global warming mitigation efforts, and this trend is expected to continue, with more and more wells being

drilled for this purpose. Geologic storage is also known as geologic sequestration or geosequestration. The CO₂ for the geologic storage is not removed from the atmosphere but comes from industrial facilities that emit large amounts of CO₂ such as coal power stations, petroleum refineries, oil and gas production facilities, iron and steel mills, cement plants

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and various chemical plants. The large-scale underground storage of CO₂ has the potential to play a key role in reducing global greenhouse gas emissions. Typical underground storage reservoirs would lie at depths of 1 km or more and contain 10 or even 100x10⁶ tones of CO₂. To date, the technology as a whole has only been deployed at a few pilot sites around the world: Sleipner field in Norway, Weyburn field in Canada, In Salah field in Algeria (Gallo et al., 2002; Jimenez & Chalaturnyk, 2002). These projects have demonstrated successful operational experience with the injection of CO₂ into the subsurface at rates of approximately 1 x 10⁶ metric tons of CO₂ per year. According to the International Energy Agency (IEA), by the year 2050, 5x10⁹ tons of CO₂ per year could be avoided through CO₂ capture and storage, representing a 16% contribution to the reduction of global emissions needed to limit climate disruption.

An important component of a CCS project is risk assessment. A comprehensive risk assessment is needed early in the project, but risks should be continually assessed, and updated throughout the project. The importance of assessing the potential for environmental impacts from CO₂ storage is recognized by certain regulations, such as the *European council directive on storage* (Directive 2009/31/EC, 2009) and the *OSPAR Guidelines for Risk Assessment and Management of Storage of CO₂ Streams in Geological Formations* (OSPAR, 2007), and other sources of guidance such as the United States Environmental Protection Agency (US EPA) *Vulnerability Evaluation*

Framework (United States Environmental Protection Agency, 2008) and the *CO₂QUAL-STORE Guideline for Selection and Quantification of Sites and Projects for Geological Storage of CO₂* (Det Norske Veritas, 2009).

They all recognize that the primary issue to be assessed and demonstrated for CCS sites is long-term containment. However, they all also recognize the importance of assessing the potential for environmental impacts should there be any leaks.

One key component of a risk assessment is identifying potential leakage pathways (e.g., faults, wells, fractures). This identification is then integrated with the Measurement, Monitoring, and Verification (MMV) program and includes, if injected CO₂ migrates toward an identified pathway, approaches to mitigate the risk of negative impacts upon the surface, a Underground Sources of Drinking Water (USDW), or outside the project footprint or to implement remediation measure. One method for ensuring this needed integration is to link the models used for risk assessment and the subsurface models that are developed and informed by MMV (Forbes et al., 2008). A lot of literature is published with the aim of assessing the risk of CO₂ storage (Benson et al., 2002; Vendrig et al., 2003; White et al., 2003)

Various methodologies are currently being applied to risk assessment of geological CO₂ storage and only some of them will be mentioned here (Le Guen et al., 2008; Forbes et al., 2008; Le Guen et al., 2009).

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